Catching gamma ray bursts on the fly . . .

Interface Control Document (ICD) Between the Swift Instrument Teams and the Mission Operations Center (MOC)

Swift-OMI-006

Baseline

Version 1.0

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Swift Ground Segment

Omitron Inc.

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REVISION STATUS

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1.0 INTRODUCTION

1.1 PURPOSE

This Interface Control Document (ICD) defines the interfaces, formats, schedules, and procedures for delivering products between the Swift Mission Operations Center (MOC) located at The Pennsylvania State University (PSU), State College, PA, and the Swift Instrument Teams. The Instrument Teams include the Burst Alert Telescope (BAT) team located at Goddard Space Flight Center (GSFC), and the X-Ray Telescope (XRT) and Ultra-Violet Optical Telescope (UVOT) teams located at PSU.

1.2 SCOPE

This document governs the technical interfaces, product deliveries, and protocols between the MOC and the Swift Instruments. Specific message and data product examples are included in the appendices.

1.3 DOCUMENTATION

1.3.1 Applicable Documents

The interfaces defined in this ICD were derived from high-level requirements contained in the following sources:

- *Swift Science Requirements Document*, GSFC-661-Swift-SRD, 410.4-SPEC-0005D, March 12, 2001.
- *Swift Mission Requirements Document*, 410.4-SPEC-0004, Version 2.2, October 9, 2001.
- *Requirements of the Ground System for the Swift Mission*, 410.4-SPEC-0007, Revision 1.0, September 12, 2000.
- *Swift Interface Requirements Document*, 410.4-ICD-0001, Version 3.2, December 13, 2001.

1.3.2 Reference Documents

The following documents contain background information relevant to this ICD:

- *Swift Mission Operations Concept Document*, Swift-OMI-001, Baseline Version 1.1, July 2001.
- *MOC Design Specification Document*, Swift-OMI-003, Version 1.0, February 28, 2002.
- CCSDS 701.0-B-2**:** *Advanced Orbiting Systems, Networks and Data Links: Architectural Specification*. Blue Book. Issue 2. November 1992. (Reconfirmed June 1998.)
- *ITOS Naming Convention/Database Format Control Document (DFCD),* Swift-OMI-013, Version 1.2, May 31, 2002.
- *Swift Telemetry and Command Handbook.*
- *Swift Instrument Telemetry Formats Standards*, 410.4-Spec-0030, Version 1.1, March 26, 2002.
- *Spacecraft To Mission Operations Center (MOC) Interface Control Document,* 1143-EI-M022927, May 24, 2001.

2.0 FACILITIES OVERVIEW

2.1 SWIFT GROUND NETWORK DESCRIPTION

The Swift ground system is comprised of new and existing facilities. The Ground Network for Swift (GNEST) is the organizational entity responsible for ensuring that interface requirements are met between ground system elements. The interface between the MOC and Swift Instruments will be tested and verified as part of the GNEST mission readiness test program.

The MOC is responsible for operating the spacecraft and its payload. The Swift Data Center (SDC) is responsible for processing Swift telemetry into scientifically useful data sets and for making these data available to the community. The Italian Swift Archive Center (ISAC) and the United Kingdom Data Center (UKDC) will provide services for scientists in those countries. The Swift Science Center (SSC) at GSFC will support the community with data analysis and will also provide tools for analyzing Swift data. The Italian Space Agency's (ASI) Malindi Ground Station and NASA's Space Network (SN) will provide the primary communication links with Swift. The Instrument Teams are responsible for providing detailed knowledge of the operation and calibration of the instruments. The spacecraft contractor, Spectrum Astro, will provide detailed knowledge of the operation of the spacecraft. The Swift Ground System mission architecture overview is shown in Figure 2-1.

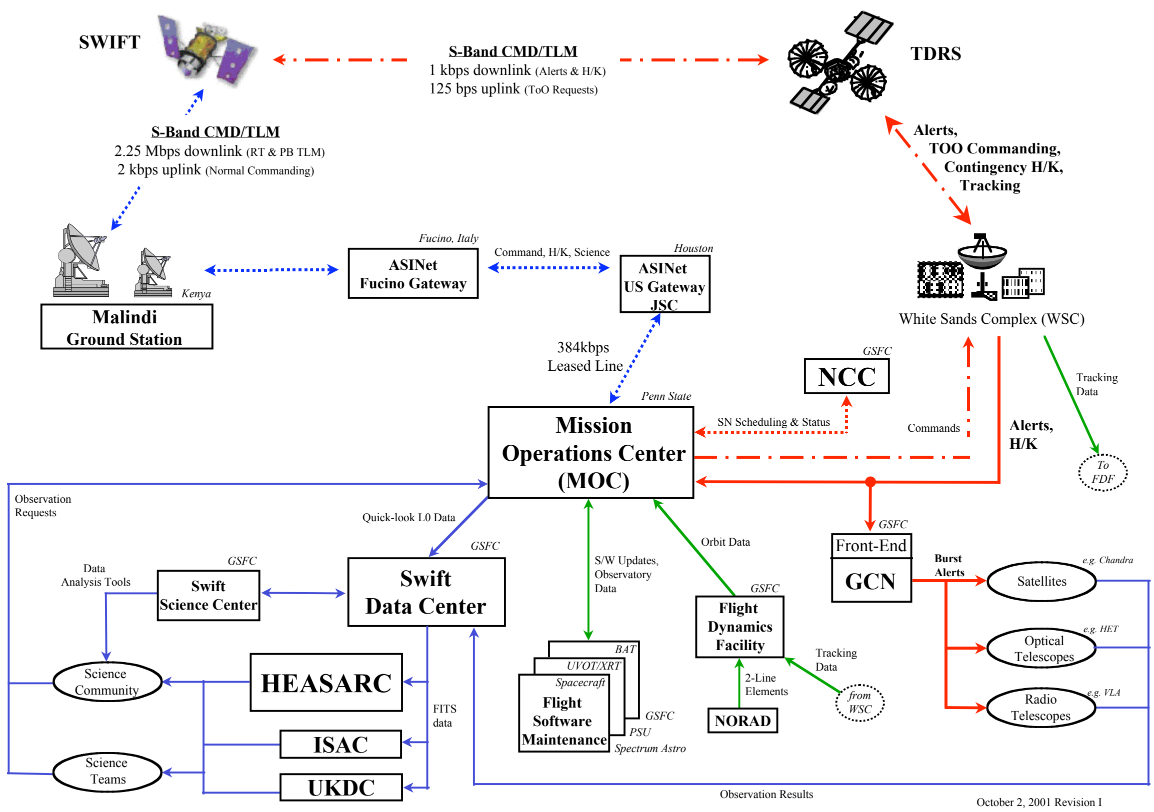

Figure 2-1: Swift Mission Architecture

The Swift Principal Investigator (PI) is the ultimate authority for all decisions concerning the mission. The Swift Science Team will review the implementation strategies of the ground system and provide recommendations to the PI.

The High Energy Astrophysics Science Archive Research Center (HEASARC) is the designated U.S. data center responsible for public access and long-term archive. All data from Swift observations will be rapidly delivered to the three Swift data centers. These data centers will make the data available electronically to the public.

2.2 MOC DESCRIPTION

The MOC performs all spacecraft and instrument mission planning, commanding, monitoring, and data processing and delivery to the SDC. The MOC provides rapid response for the follow-up of new Gamma-Ray Bursts (GRBs) detected by the spacecraft, and for Target of Opportunities (ToOs) requested by the science team or science community. The MOC incorporates automation of spacecraft operations and data processing to permit a small operations team and "lights-out" operation, and to speed data processing and response to GRBs and ToOs. The MOC will be staffed by a Flight Operations Team (FOT) and a Science Operations Team (SOT) on an eight-hour per day, five-day per week basis. MOC automation software will also identify potential anomalies and notify personnel if necessary. The MOC shall generate Level 0 (L0) telemetry data, and provide the data to the SDC and Instrument Teams. The L0 data will be retained online for 7 days and archived for the life of mission. A subset of the housekeeping telemetry is maintained online for 30 days, and trend data is accumulated over the life of the mission. In addition, the raw telemetry files, command logs, clock offset values, orbit data (TLEs), the as-flown timelines, and MOC processing statistics and status are archived for the life of mission.

The MOC is based on the Integrated Test and Operations System (ITOS) command and telemetry system, government-off-the-shelf (GOTS) software products, and commercial-off-the-shelf (COTS) hardware and software tailored for Swift mission support. ITOS provides all command and telemetry functions, such as front-end processing, command and telemetry processing, real-time monitoring, and archiving. Computer security, with use of firewalls and other techniques, prevents intrusion and disruption of operations.

The MOC shall receive all transfer frames from the Malindi ground station or the Tracking and Data Relay Satellite System (TDRSS) SN link. The MOC shall produce L0 products and deliver these products to the SDC. The L0 processing functions include the decoding of transfer frames, the extraction of Consultative Committee for Space Data Systems (CCSDS) packets, and the creation of L0 products with associated quality and gap accounting. All Swift transfer frames shall be archived as received from the ground station (or TDRSS) by the MOC for the duration of the mission.

2.3 SWIFT INSTRUMENT TEAMS DESCRIPTION

The Swift Instrument Teams include the BAT team located at GSFC, and the XRT and UVOT teams primarily located at PSU, with additional support from teams at the University of Leicester, the Mullard Space Science Laboratory, and the Brera Observatory. The Instrument

Teams maintain facilities for the maintenance of instrument flight software and for the analysis of instrument performance. These sustaining engineering facilities receive engineering data from the MOC, and provide flight software loads and commands to the MOC for uplink to the spacecraft.

The Instrument Teams also provide participants as members of the SOT within the MOC to perform science planning and assessment of science data and instrument performance. The SOT utilizes science workstations in the MOC to receive and process telemetry, perform analysis tasks, and perform science observation planning. Instrument Teams may have instrument-specific software running on their science workstation to perform tasks specific to that instrument. The ITOS will also be running on the science workstations to decommutate engineering telemetry and provide displays. The Instrument Teams may also have remote instrument-specific science workstations external to the MOC to receive and process telemetry and perform analysis and monitoring tasks.

2.4 DATA INTERFACE

The data interfaces between the MOC and the Instrument Teams are summarized in Figure 2-2. The MOC provides real-time telemetry and post-pass telemetry files to the science workstations in the MOC and to the sustaining engineering facilities. The Instrument Team sustaining engineering facilities provide real-time commands and flight software loads to the MOC prior to real-time supports designated for such activities.

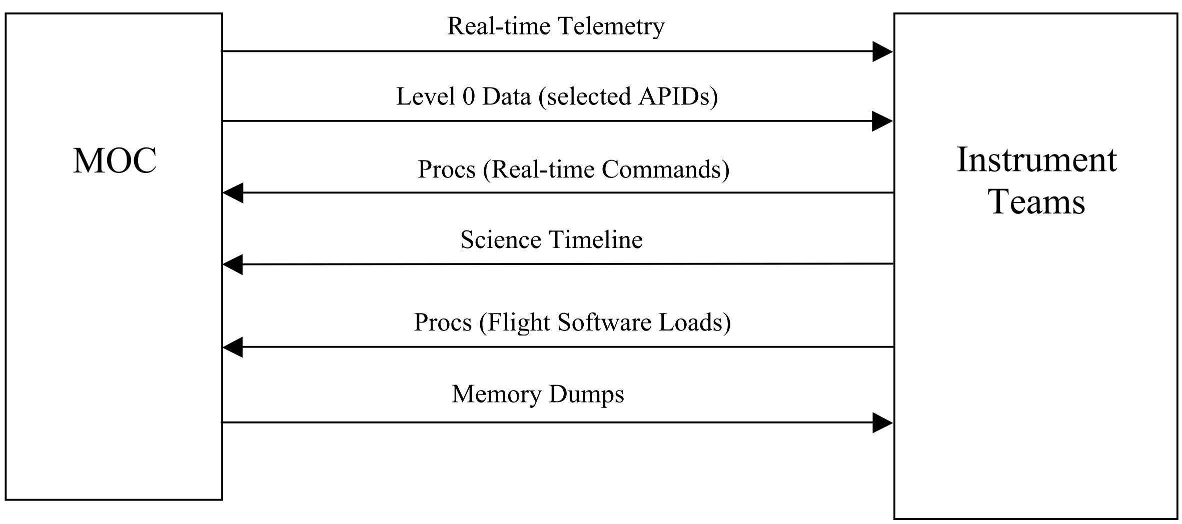

Figure 2-2: MOC - Instrument Teams Interface

3.0 PRODUCTS AND FORMATS

Table 3-1 summarizes all of the products transferred between the MOC and the Swift Instrument Workstations. The appendices provide samples of each product. The following subsections provide more detail on each product's content and attributes.

Table 3-1: MOC Data Products

Product	Contents	Timespan	Delivery Rate	Transfer Media	Size
Real-time Data Product	VC0 packets	One Pass	Real-time during each Pass	TCP/IP socket	<3.6 MB
Level 0 Data	All processed packets	One Pass	Once per Pass	sftp	approx. 45-160 Mbyte/pass
Real-time Commanding	Within ITOS procs	One Pass	As needed	sftp	Minimal (varies)
Instrument Loads	Within ITOS procs	One Pass	As needed	sftp	Minimal (varies)
Memory Dumps	Specified packets	One Pass	As needed	sftp	Minimal (varies)
Science Timeline	Preplanned science timeline	7 Days (nominal); 3 days minimum	Once per day (1 per week minimum)	sftp	Variable, <20KB (approx.)

This ICD follows the CCSDS bit ordering and bit significance convention for serial telemetry links as shown in Figure 3-1. The first bit in a field of N bits is defined as "Bit 0" (i.e., the most left justified appears first in this ICD and is the first transmitted); the following bit is defined as "Bit 1" and so on up to "Bit N-1". Data fields are grouped into 8-bit "words" called octets or bytes. Each byte contains an American Standard for Code Information Interchange (ASCII) character or binary data.

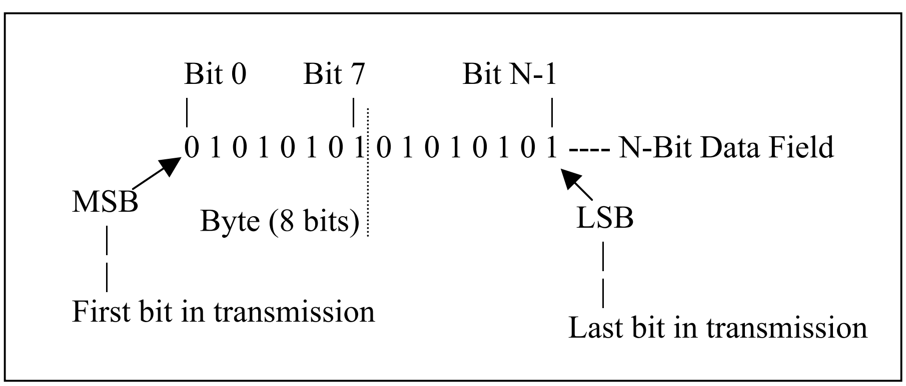

Figure 3-1: Data Format Convention

3.1 REAL-TIME DATA PRODUCT

The MOC is responsible for spacecraft and instrument health and safety monitoring, as well as the verification of nominal mission execution and system status. The MOC monitors received real-time state-of-health (SOH) telemetry for out-of-limit situations, and proper spacecraft and/or instrument configuration. The MOC receives all CCSDS-compliant real-time VC0 telemetry frames from the Malindi Ground Station. The SOT science workstations within the MOC can be configured to receive the real-time VC0 telemetry data from the MOC/ITOS workstation. The real-time data can be displayed on each science team workstation connected to the prime ITOS workstation.

3.1.1 Data Format

All real-time data transmitted by the prime MOC/ITOS workstation is formatted into ITOS messages for transport through secure data lines to the SOT/ITOS workstations. The message format consists of an ITOS ITP message header identifying the message type and a variable-length message data field consisting of one or more packet data units (PDUs), as shown in Figure 3-2. The structure of the ITP message header is shown in Table 3-2. Quality information is appended to each CCSDS source packet to form a PDU.

MESSAGE HEADER (16 bytes)	MESSAGE DATA (variable length)

Figure 3-2: ITOS Message

Table 3-2: ITOS ITP Message Header

Field Name	Bytes	Description
Message Length	0-1	Message length, including ITP header.
Message Class	2-3	Message data class; for example: telemetry, command, etc.
Message Type	4-5	
Signature	6-7	
Message Subtype	8-11	
PDU Count	12-13	In some contexts, the number of packet data units in the message.
User Area	14-15	16

ITOS will extract the CCSDS Version 1 Telemetry Source Packets from the CCSDS telemetry frames. The structure of the CCSDS Path Protocol Data Unit (CP_PDU) is shown in Figure 3-3.

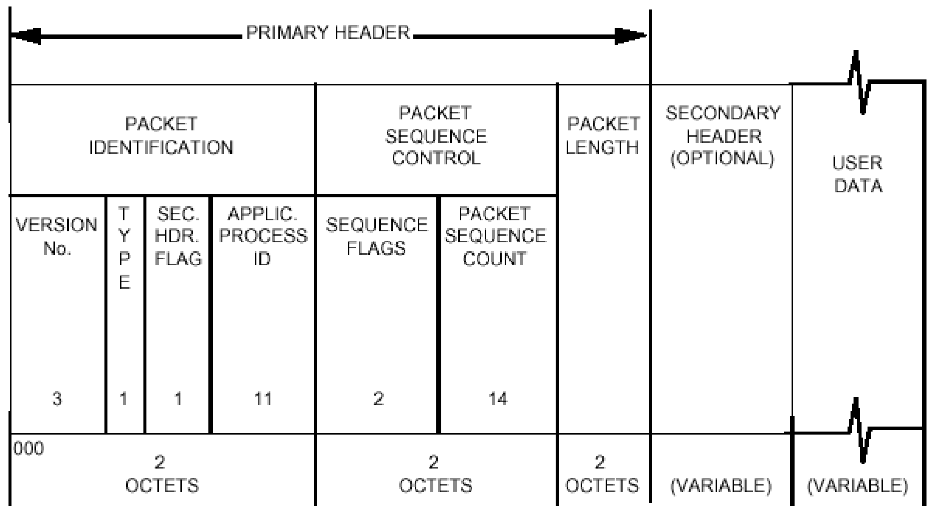

Figure 3-3: CCSDS Path Protocol Data Unit

The Primary Header shall consist of 6 bytes subdivided into the fields shown in Table 3-3. [CCSDS 701.0-B-2 (Blue Book), Section 3.3.3].

Table 3-3: CCSDS Primary Header Format

Field Name	**Sub-Field Name**	**#Bits**	**#Bytes**
Packet Identification	Version Number	3	
	Type	1	
	Secondary Header Flag	1	
	Application Process ID	11	2
Packet Sequence Control	Sequence Flags	2	
	Packet Name or Sequence Count	14	2
Packet Length		16	2
TOTAL		48	6

A single ITOS Packet Data Unit (PDU), shown in Figure 3-4, consists of a CCSDS telemetry source packet annotated with a 12-byte quality information header.

ANNOTATION HEADER (12 bytes)	CCSDS TELEMETRY SOURCE PACKET

Figure 3-4: Packet Data Unit

The packet annotation header is 12 bytes in length and the format is shown in Table 3-4.

Table 3-4: Packet Annotation Header Content and Format

Field	Word (16-bit)	Bit Location	Description/Values
Frame version	1	Bits 0-1	Copied from transfer frame header
Frame spacecraft identifier (SCID)	1	Bits 2-11	Copied from transfer frame header
Frame VCID	1	Bits 12-14	Copied from transfer frame header
Reserved	1	Bit 15	
Reed-Solomon Enabled	2	Bit 0	0 = RS error detection and correction not enabled 1 = RS error detection and correction enabled
Reed-Solomon error	2	Bit 1	0 = no uncorrectable RS error detected 1 = uncorrectable RS error detected
Reed-Solomon corrected	2	Bit 2	0 = no RS error detected 1 = RS corrected one or more error
Reserved	2	Bit 3	
Time format	2	Bits 4-7	Defines time code format.
Packet header error	2	Bit 8	0 = packet from frame without CRC error 1 = packet from frame with CRC error
Data direction	2	Bit 9	0 = data received in forward order 1 = data received in reverse order
Packet sequence error	2	Bit 10	0 = no discontinuity found in packet sequence count 1 = this packet's sequence count not successor of previous packet with same APID on same VC
Frame CRC error	2	Bit 11	0 = no CRC error detected 1 = CRC error detected in one or more frames from which this packet is extracted
Frame error checking enabled	2	Bit 12	0 = frame error checking not enabled 1 = frame error checking enabled
Incomplete packet	2	Bit 13	0 = packet is complete 1 = packet is incomplete and filled to specified length (see "location of fill")
VC sequence error	2	Bit 14	0 = no discontinuity found in frame VC sequence count 1 = Transfer frame's VC sequence count is not successor of previous frame on same VC

Field	Word (16-bit)	Bit Location	Description/Values
Frame header error	2	Bit 15	0 = no error 1 = SCID or transfer frame version was not the expected value
Location of fill	3	Bits 0-15	0 to 65,535 (unsigned value); identifies first byte of fill data in byte offset from end of packet primary header
Ground receiving time	4-6	Bits 0-15	Local processing time in format defined in "time format", word 2, bits 4-7 above

3.1.2 Data Transfer Mechanism

Real-time telemetry packet data formatted into ITOS messages will be transmitted from the MOC/ITOS workstation over a TCP/IP socket connection to the SOC/ITOS workstations.

3.2 LEVEL 0 DATA

The MOC shall receive all CCSDS-compliant telemetry frames from the Malindi ground station and the TDRSS Demand Access Service (DAS) link. Pass-oriented L0 products will be generated on all mission telemetry and maintained within the mission archive at the MOC. The L0 processing functions include the decoding of transfer frames, the extraction of CCSDS packets sorted by Application Process ID (APID), and the creation of L0 products with associated quality and gap accounting. The MOC will notify the Instrument Teams of the availability of the L0 data products electronically within 90 minutes after receipt of data from a ground station contact.

After each Malindi pass, the MOC will receive Virtual Channel (VC) telemetry frame files. As each file is received, the MOC will automatically process the file through the ITOS frame sorter task and create individual L0 packet files with appended Annotation Headers organized by APID. Each Instrument Team specifies a subset of APIDs to receive from the MOC at the beginning of the mission. This pre-defined list of APIDs can be modified on a periodic (but infrequent) basis, via email to the FOT. After the L0 files are created, the MOC will then send a signal file (directory listing) via secure file transfer protocol (sftp) to the Instrument Team workstations providing a notification of available data. The Instrument Teams will retrieve the available files from the MOC fileserver via sftp.

3.2.1 Data Format

An L0 product is created from a single virtual channel frame file, and consists of files, each one containing ITOS packet annotation headers and the CCSDS telemetry source packets for a single APID. The L0 product format is the same format as the PDU shown in Figure 3-4.

The L0 data file naming convention will be as follows:

```
PKT_YYYYDOYhhmm_nnnnn_VCNN_ppppp.0.gz
```

where:

- PKT is a fixed field indicating that the file is a packet file
- YYYYDOYhhmm is the time tag (GMT) of the first error-free TLM Transfer Frame from which the L0 packet file was generated, where:
  YYYY is the calendar year
  DOY is the day of year
  hh is the hour
  mm is the minute
- nnnnn is the Pass Number (counter for each passage over Malindi) in which the Transfer Frame was received at Malindi (nnnnn in decimal representation)
- VCNN is the Virtual Channel ID (NN in decimal representation)
- ppppp represents the APID of the packets contained within the packet file (If the file is a composite of all APIDs from the frame file, the APID number will be 99999.)
- 0 is a fixed field
- gz is the extension indicating the file is compressed with gzip

In the event of a data anomaly, suspect packet files can be traced to their parent frame files via time stamp and pass number. Example L0 file names are as follows:

```
PKT_20031040234_02343_VC01_00873.0.gz
PKT_20050992359_16534_VC01_99999.0.gz
```

3.2.2 Data Transfer Mechanism

A data delivery content listing, or signal file, will be provided with each set of L0 products generated from a telemetry frame file. The signal file will consist of an ASCII text file listing the complete path and file names of all created L0 packet files. The L0 signal file will be delivered by the MOC to the Instrument Team workstations (local and remote) via sftp when data is available for transfer. After the Instrument Team workstation receives the L0 signal file, the Instrument Team workstation will retrieve the L0 products indicated in the signal file from the MOC via sftp.

The L0 signal file naming convention will be as follows:

```
SIG_YYYYDOYhhmm_nnnnn_VCNN.txt
```

where:

- SIG is a fixed field indicating that the file is a signal file
- YYYYDOYhhmm is the time tag of the first error-free TLM Transfer Frame from which the L0 packet files were generated, where:
  YYYY is the calendar year
  DOY is the day of year
  hh is the hour

mm is the minute

- nnnnn is the Pass Number in which the Transfer Frame was received at Malindi (nnnnn in decimal representation)
- VCNN is the Virtual Channel ID (NN in decimal representation)
- txt is a fixed field file extension

The file format of the L0 signal file will be as follows:

```
user@hostname:/path/filename1.gz
user@hostname:/path/filename2.gz
user@hostname:/path/filename3.gz
```

where:

- user is the username the Instrument Team must use when logging into the MOC computer
- hostname is the fully qualified domain name of the computer that the Instrument Team must log into
- path is the directory on the hostname computer that the L0 files reside in
- filenamex is the L0 filename to retrieve
- gz is the extension indicating the file is compressed with gzip

Example L0 signal file filename:

SIG_20033452302_55555_VC03.txt

Example L0 signal file contents:

```
sdc@swiftopen.psu.edu:/home/sdc/PKT_20033452302_55555_VC03_00873.0.gz
sdc@swiftopen.psu.edu:/home/sdc/PKT_20033452302_55555_VC03_00874.0.gz
sdc@swiftopen.psu.edu:/home/sdc/PKT_20033452302_55555_VC03_00875.0.gz
sdc@swiftopen.psu.edu:/home/sdc/PKT_20033452302_55555_VC03_00876.0.gz
```

3.3 PROCS

An ITOS proc is a file containing ITOS Spacecraft Test & Operations Language (STOL) directives to automate ITOS tasks. For the Instrument Teams, the procs shall be used for all instrument commanding operations including: real-time, normal operations, and contingency operations commanding.

The format of the ITOS procs shall conform to the ITOS proc style guidelines and the naming convention as specified in the *ITOS Naming Convention/Database Format Control Document (DFCD)*.

The MOC shall receive new or updated procs from the Instrument Teams on a periodic basis, as needed. The files shall be transferred to the MOC open web server using the sftp protocol. A representative from each Instrument Team shall have a restricted account on the open web server, which allows them to login to the web server, and transfer new or updated procs to the MOC. Each Instrument Team will be responsible for validating and quality checking the proc before delivery to the MOC.

The Instrument Teams will transfer the procs into the appropriate directory in which they want the proc to reside on the closed MOC fileserver. The directory structure for the incoming procs on the open web server will mirror the directory structure on the operational MOC fileserver. ITOS STOL procs will reside in multiple team directories starting from the $HOME/swift/procs directory (i.e. $HOME/swift/procs/sc, $HOME/swift/procs/bat, etc.). Each representative will only have the privileges to transfer a file to their portion of the incoming proc directory structure.

3.4 INSTRUMENT COMMANDING

3.4.1 Real-time Commands

Real-time commands are uplinked from the MOC for immediate execution during spacecraft ground station or TDRSS contacts. During Launch & Early Orbit (L&EO) operations, real-time commanding can consist of nearly any spacecraft or instrument activity. During normal operations, real-time commands will primarily consist of Absolute Time Sequence (ATS) and Relative Time Sequence (RTS) table loading, Solid State Recorder (SSR) redumping activities, clock correction factor updates, and unplanned instrument activities. Swift uses the CCSDS Command Operation Procedure - 1 (COP-1) protocol to verify receipt of real-time commands during a ground station contact. For TDRSS contacts, receipt of real-time commands is confirmed by end-item telemetry verification. The MOC maintains an electronic log of real-time commands that have been sent and verified. An updated log covering one day of commanding is provided to the SDC within seven days of command execution.

All real-time commands are provided from the Instrument Teams to the MOC contained in an ITOS proc. The Instrument Teams will notify and coordinate with the FOT when real-time commands need to be sent to the spacecraft. Each Instrument Team will be responsible for validating and quality checking the proc before delivery to the MOC. The delivery of the procs to the MOC is described in Section 3.3.

3.4.2 ToO Requests

ToOs are submitted to the MOC using a web-based form. The decision whether to disrupt planned science operations to observe the ToO is made according to guidelines approved by the Swift PI. The MOC acknowledges receipt of each ToO within an hour, and will inform the ToO requester of its decision within 24 hours. An electronic log is also maintained showing all ToOs received and their disposition. The SOT will be notified via e-mail for each ToO and via page if time critical.

Assessment of a ToO includes: the need for rapid response, the scientific merit and goals of the ToO, the credibility of the request, and its impact on spacecraft resources and ongoing operations. The SOT provides a technical evaluation to the Swift PI. Following a decision by the Swift PI or his representative to observe the ToO, the SOT responds to include the ToO in the operational timeline. Depending on how rapid a response is needed, the position and merit can be uploaded to the Figure of Merit (FoM) via a real-time command or a short-term revision of the schedule can be uploaded via TDRSS or ground contact.

3.4.3 Stored Command Requests

The Instrument Teams may have on occasion a need to have instrument commands included in the ATS or RTS for uplink to the spacecraft. The Instrument Teams will coordinate with the SOT on all command requests. The SOT then provides these stored command requests to the FOT via email. The email message must include the requested commands to be inserted into the ATS/RTS, the timeframe that the commands must be uplinked, and a description of the commands and any special handling or other considerations. For non-nominal instrument commanding, the SOT email to the FOT must also be followed by a phone call from the SOT to the FOT to confirm the commanding operation is valid.

The FOT will manually add the commands into the Mission Planning System (MPS) and generate the ATS and RTS loads. The FOT will notify the SOT of the completion of the request and if requested, provide a report of the ATS/RTS contents prior to uplink for confirmation by the SOT.

3.5 INSTRUMENT LOADS

Instrument loads to the XRT and UVOT/Data Processing Unit (DPU) will be provided to the MOC using an ITOS proc. Instrument loads to the BAT and UVOT/Instrument Control Unit (ICU) instruments will be provided to the MOC in the form of ITOS load files that consist mainly of the data to be loaded, in ASCII hexadecimal notation, and the proc that contains the commands necessary to complete the load. The Instrument Team must also provide the procedure for accomplishing the load, or specific reference to an existing procedure. A description of the ITOS load format can be found in the ITOS user documentation on the world wide web (www) at:

`http://itos.gsfc.nasa.gov/ITOS/itos-cmd/Image_Loads.html`

The Instrument Teams will notify (via phone call) and coordinate with the FOT when Instrument loads need to be sent to the spacecraft. Each Instrument Team will be responsible for validating and quality checking the instrument load before delivery to the MOC. The Instrument Teams will transfer the loads into the appropriate directory on the open web server. The FOT will retrieve the files from the open web server into the operational MOC fileserver. ITOS load files will reside in multiple team directories starting from the $HOME/swift/loads directory (i.e. $HOME/swift/loads/sc, $HOME/swift/loads/bat, etc.). Each representative will only have the privileges to transfer a file to their portion of the incoming load directory structure.

3.6 MEMORY DUMP PRODUCT

The Instrument Teams will notify and coordinate with the FOT for Instrument memory dumps. The Instrument Teams will provide the proc name to be used for the memory dump or provide a new proc to accomplish the dump. The Instrument Teams will also provide a time frame for the dump to occur.

Each instrument will have designated certain APIDs, as defined in the *Swift Telemetry and Command Handbook,* to downlink memory dump data. The MOC will create a L0 product for the memory dump APID and provide the products to the SDC. The Instrument Teams will retrieve the memory dump data from the SDC.

3.7 PREPLANNED SCIENCE TIMELINE

During each workday's science planning process, the SOT shall produce a Preplanned Science Timeline (PPST). The MOC maintains a Master PPST that will contain the merged PPST's for several days in the past and several days in the future. The SOT will promote the new PPST to the MOC open web server using the sftp protocol. The PPST shall be in ASCII and contain information in columnar format with '|' separators. The PPST format is shown in Table 3-5. An example timeline is provided in Appendix A-1.

Table 3-5: Preplanned Science Timeline Format

Column	Description	Format
1	GMT Time of event	YYYY-DOY-HH:MM:SS
2	Type of event[1]	Text: PPT, SAA, …
3	Begin or End of event	Text: Begin or End
4	Target name	Text: Target name or Global [2]
5	Target ID	Unsigned integer (24 bits)
6	Observation segment	Unsigned integer (8 bits)
7	Observation number (combination of target ID and observation segment)	Unsigned integer (32 bits): Low order 24 bits = Target ID High order 8 bits = observation segment
8	RA of target in degrees decimal.	Floating point (64-bit)
9	DEC of target in degrees decimal	Floating point (64-bit)
10	Roll of target in degrees decimal	Floating point (32-bit)
11	BAT mode	Unsigned integer (16 bit)

[1] The only type of event required for MPS is a "PPT" event. All other events are just informational and can be optionally excluded through the science scheduling software (TAKO).

[2] The 'Global' target name only applies to non-PPT event types such as SAA, which apply to all targets.

Column	Description	Format
12	XRT mode	Unsigned integer (16 bit)
13	UVOT mode	Unsigned integer (16 bit)
14	Merit value	Floating point (32-bit)
15	Requested Observation Seconds	Unsigned integer (32-bit)
16	Remarks	Text
17	Target Database Filename	Text

All items will be provided for Preplanned Target (PPT) type events. For non-PPT type events, only items in columns 1-4 will be provided.

The PPST will be produced by the MOC science planning software and will be stored on the MOC public web server for retrieval. Because of possible re-planning activities, multiple PPSTs may be produced during a single mission day. The MOC maintains a Master PPST, which is a consolidation of several weeks of PPST data.

The Master PPST file naming convention will be as follows:

```
MasterPPST.txt
```

An archive of the Master PPSTs will be maintained and made available on the MOC public web server. The archived Master PPSTfiles will contain entries prior to the current Master PPST file. New archive files will be created as needed so that each file is a manageable size. The archived Master PPST file naming convention is as follows:

```
MasterPPST_YYYYDOYhhmm_YYYYDOYhhmm.txt
```

where:

- MasterPPST is a fixed field indicating that the file is a Preplanned Science Timeline file
- YYYYDOYhhmm is the start and end timeframe (GMT) covered within the file where:
  - YYYY is the calendar year
  - DOY is the day of year
  - hh is the hour
  - mm is the minute
- .txt is an extension file type readability

3.8 ANOMALY NOTIFICATIONS

The MOC will notify the Swift Instrument Teams after any spacecraft or instrument anomaly. This notification shall consist of e-mail dispatches from the Spacecraft Emergency Response System (SERS) anomaly-reporting software. The MOC will notify the Instrument Team by voice for any significant instrument anomaly, as specified in contingency response plans. As MOC resources allow, the MOC may provide the Swift Instrument Teams with more detailed status updates during the anomaly resolution process. Subsequent anomaly status updates may also be posted on the Swift Web page.

3.9 DATA ANALYSIS AND REMOTE ACCESS

The Instrument Teams provide sustaining engineering support during the mission. Remote access to the MOC archive data allows the Instrument Teams to review instrument housekeeping data, analyze L0 science data, and perform trending of selected subsystem parameters. The Data Trending and Analysis System (DTAS) provides the capability for the user/client to view plots and tables of the housekeeping and trend data and save these products to a file. Each Instrument Team will have the DTAS client application software installed on a user workstation using an install shield that can be downloaded via the MOC web site. The client application consists of a Trending Tool and an Analysis Tool. The Trending Tool allows a user to plot individual mnemonics vs. time including min, max and mean. The Analysis Tool allows the user to view tables, plots, statistics and compare data. Additional details of the DTAS capabilities can be found at:

`http://radlab.gsfc.nasa.gov/DTASHome.html`

The Instrument Teams may also view real-time telemetry during a pass via ITOS Java display pages over the internet. The remote user accesses the pages via a web browser. The MOC open server hosts a web server that will be used to service the instantiation of an ITOS Java client initiated by a remote instrument engineer. The ITOS Java client script is responsible for launching the ITOS Java client when initiated to do so by a remote instrument engineer. Once the ITOS Java client is launched it makes a socket connection to the ITOS Datapoint server. The ITOS Java client script is GOTS software and merely needs to be installed on the target platform in the proper directory.

The Instrument Teams may have instrument-specific software on their science workstations in the MOC for instrument data processing, monitoring, etc. The Instrument Teams may also have remote instrument-specific science workstations external to the MOC. These remote workstations can receive L0 telemetry files from the MOC for processing, in the same manner as described in section 3.2. The remote workstations may also receive data from the instrument-specific software on their science workstation in the MOC. The format and content of this data and configuration of the transfer mechanism is controlled by the individual Instrument Team, and is not within the scope of this ICD. The configuration must however be compliant with the MOC network security architecture.

APPENDIX A: Product Examples

A.1 Preplanned Science Timeline Example

```
2002-119-14:07:00 | saa | enter | Global
2002-119-14:27:00 | saa | exit | Global
2002-119-15:17:00 | PPT | Begin | Cas A | 22 | 2 | 33554454 | 350.8 | 58.81 | 0 | 0 | 0 | 0 | 100 | 402 |
Planning Exercise | targ_2002129_1649_DB.tcl
2002-119-15:17:00 | mnv | Begin | Cas A
2002-119-15:18:00 | mnv | End | Cas A
2002-119-15:24:00 | PPT | End | Cas A | 22 | 2 | 33554454 | 350.8 | 58.81 | 0 | 0 | 0 | 0 | 100 | 402 |
Planning Exercise | targ_2002129_1649_DB.tcl
2002-119-15:24:00 | PPT | Begin | GRB990712 | 8 | 2 | 33554440 | 337.9568 | -73.4066 | 0 | 0 | 0 | 0 | 100
| 2026 | Planning Exercise | targ_2002129_1649_DB.tcl
2002-119-15:24:00 | mnv | Begin | GRB990712
2002-119-15:27:00 | mnv | End | GRB990712
2002-119-15:53:00 | occult | enter | Cas A
2002-119-15:55:00 | saa | enter | Global
2002-119-15:59:00 | PPT | Begin | GRB980329 | 3 | 2 | 33554435 | 106.16 | 41.56 | 0 | 0 | 0 | 0 | 100 |
2813 | Planning Exercise | targ_2002129_1649_DB.tcl
2002-119-15:59:00 | mnv | Begin | GRB980329
2002-119-15:59:00 | PPT | End | GRB990712 | 8 | 2 | 33554440 | 337.9568 | -73.4066 | 0 | 0 | 0 | 0 | 100 |
2026 | Planning Exercise | targ_2002129_1649_DB.tcl
2002-119-16:02:00 | mnv | End | GRB980329
2002-119-16:07:00 | saa | exit | Global
2002-119-16:10:00 | occult | enter | GRB990712
2002-119-16:47:00 | PPT | End | GRB980329 | 3 | 2 | 33554435 | 106.16 | 41.56 | 0 | 0 | 0 | 0 | 100 | 2813
| Planning Exercise | targ_2002129_1649_DB.tcl
2002-119-16:47:00 | occult | enter | GRB980329
2002-119-16:56:00 | PPT | Begin | Cas A | 22 | 2 | 33554454 | 350.8 | 58.81 | 0 | 0 | 0 | 0 | 100 | 343 |
Planning Exercise | targ_2002129_1649_DB.tcl
2002-119-16:56:00 | mnv | Begin | Cas A
2002-119-16:56:00 | occult | exit | Cas A
2002-119-16:57:00 | mnv | End | Cas A
2002-119-17:03:00 | PPT | End | Cas A | 22 | 2 | 33554454 | 350.8 | 58.81 | 0 | 0 | 0 | 0 | 100 | 343 |
Planning Exercise | targ_2002129_1649_DB.tcl
2002-119-17:03:00 | PPT | Begin | GRB990712 | 8 | 2 | 33554440 | 337.9568 | -73.4066 | 0 | 0 | 0 | 0 | 100
| 2027 | Planning Exercise | targ_2002129_1649_DB.tcl
2002-119-17:03:00 | mnv | Begin | GRB990712
2002-119-17:03:00 | occult | exit | GRB990712
2002-119-17:06:00 | mnv | End | GRB990712
2002-119-17:33:00 | occult | enter | Cas A
```

ACRONYM LIST

APID	Application Process ID
ASCII	American Standard Code for Information Interchange
ASI	Italian Space Agency
ATS	Absolute Time Sequence
BAT	Burst Alert Telescope
CCSDS	Consultative Committee for Space Data Systems
COP-1	Command Operation Procedure
COTS	Commercial-Off-The-Shelf
CP_PDU	CCSDS Path Protocol Data Unit
CRC	Cyclic Redundancy Check
DAS	Demand Access Service
DFCD	Database Format Control Document
DPU	Data Processing Unit
DTAS	Data Trending and Analysis System
FDF	Flight Dynamics Facility
FoM	Figure of Merit
FOT	Flight Operations Team
GCN	GRB Coordinates Network
GNEST	Ground Network for Swift
GOTS	Government-Off-The -Shelf
GRB	Gamma-Ray Burst
GSFC	Goddard Space Flight Center
HEASARC	High Energy Astrophysics Science Archive Research Center
ICD	Interface Control Document
ICU	Instrument Control Unit
ID	Identification
IRD	Interface Requirements Document
ISAC	Italian Swift Archive Center
ITOS	Integrated Test and Operations System
L0	Level zero
LSB	Least Significant Bit
Mbps	Million bits per second
MOC	Mission Operations Center
MPS	Mission Planning System
MRD	Mission Requirements Document
MSB	Most Significant Bit
NASA	National Aeronautics and Space Administration
NCC	Network Control Center
NFI	Narrow Field Instrument
NORAD	North American Aerospace Defense Command
OMI	Omitron
PA	Pennsylvania
PDU	Packet Data Unit
PI	Principal Investigator
PPT	Preplanned Target
PPST	Preplanned Science Timeline
PSU	The Pennsylvania State University
RS	Reed-Solomon
SCID	Spacecraft Identifier
SDC	Swift Data Center
SERS	Spacecraft Emergency Response System

sftp	secure file transfer protocol
SN	Space Network
SOH	state-of-health
SOT	Science Operations Team
SRD	Science Requirements Document
SSC	Swift Science Center
SSR	Solid State Recorder
STOL	Spacecraft Test & Operations Language
TAKO	Timeline Assembler, Keyword Oriented
TBD	To Be Determined
TDRSS	Tracking and Data Relay Satellite System
ToO	Target of Opportunity
UKDC	United Kingdom Data Center
UVOT	Ultra-Violet Optical Telescope
VC	Virtual Channel
VCID	Virtual Channel ID
WSC	White Sands Complex
WWW	World Wide Web
XRT	X-Ray Telescope